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PARSONS ENGINEERING SCIENCE, INC.

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November 19, 1998

Major Ed Marchand
AFCEE/ERT
3207 North Road, Bldg. 532
Brooks AFB, Texas 78235-5363

Subject: Two-Year Soil Gas Sampling and Respiration Testing Results Report for Full-Scale Bioventing at the POL Yard, Sites SS-06 and ST-40, Wurtsmith AFB, Michigan (Contract No. F41624-92-8036, Order 17)

Dear Major Marchand:

This letter report presents the results of the static soil gas sampling and respiration testing performed by Parsons Engineering Science, Inc. (Parsons ES) for the full-scale bioventing system at the former Petroleum, Oils, and Lubricants, (POL) Yard, Sites SS-06 and ST-40, Wurtsmith AFB, Michigan. Soil gas samples were collected and *in situ* respiration testing was performed by Parsons ES from 13 to 17 October 1998 to assess the extent of remediation completed during approximately 2 years of air injection bioventing. The purpose of this letter is to summarize site and bioventing activities to date, present the results of the most recent respiration testing and soil gas sampling event, and to compare these results with previous pilot testing and monitoring results. A site layout and two tables are attached. The as-built bioventing system and sampling/respiration testing locations are illustrated on Figure 1. Table 1 provides initial, 1-year, and 2-year soil gas sampling results. Table 2 provides results of respiration testing performed prior to bioventing system startup, and after 1 and 2 years of air injection bioventing.

SITE/PROJECT HISTORY

Wurtsmith AFB is presently undergoing closure activities. Site SS-06 is a former POL bulk storage facility at the Base. A layout of Site SS-06, which is inclusive of Site ST-40, is shown on Figure 1. Site SS-06 is the location of several former aboveground storage tanks (ASTs) and USTs which contained JP-4 (jet propulsion) fuel. Site ST-40, situated in the north-central portion of Site SS-06, is the location of a former UST that contained waste oil. Except for three active jet fuel ASTs in the northwest corner of the POL Yard, Site SS-06 is vacant and inactive. All former ASTs and USTs have been removed. A groundwater pump-and-treat system (referred to as the Benzene Plant), located approximately 400 feet northeast of the POL Yard, was installed to treat groundwater contaminated with benzene, toluene, ethylbenzene, xylenes (BTEX), and a free product plume originating at the POL Yard. At Sites SS-06 and ST-40, petroleum products have been released to the subsurface environment and have contaminated site soils and groundwater.

In July 1994, a passive soil gas survey was conducted by ICF Technology (1995) to determine the extent of JP-4 contamination in soils at the POL Yard. The survey was

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conducted by installing sorbent collection devices at 83 locations within and adjacent to the POL Yard. Soil gas results from the ICF Technology survey indicated high concentrations of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) within the bermed area, immediately adjacent to the former location of Tank 7000 (Figure 1).

In 1995, ICF Technology (1995) and Brown & Root Environmental (1995) collected soil samples from borings within and adjacent to the POL Yard to further delineate the extent of soil contamination at the site. Soil samples collected by Brown & Root were primarily from borings completed near the buried JP-4 fuel lines, and soil samples collected by ICF Technology were concentrated near the former AST locations. Petroleum-hydrocarbon contamination detected in these soils exceeded state soil criteria for groundwater protection, or 20 times the appropriate state drinking water value (Michigan Department of Environmental Quality [MDEQ], 1995a and 1995b). The MDEQ soil cleanup criteria for total xylenes is 5,600 micrograms per kilogram (µg/kg) for commercial/industrial and residential sites. Soil samples collected from six soil borings exceeded the total xylenes cleanup criteria. Total xylenes were detected at a maximum concentration of 50,000 µg/kg from a soil sample collected 4 to 6 feet below ground surface (bgs) near former Tank 7000. Naphthalene also was detected at a maximum concentration of 6,400 µg/kg at this location, exceeding the residential soil cleanup criteria of 5,200 µg/kg, but not the commercial/industrial criteria of 15,000 µg/kg. During these investigations, ethylbenzene, toluene, acenaphthene, fluorene, phenanthrene, and pyrene also were detected in soil samples, but at concentrations below the commercial/industrial and residential cleanup criteria. Additionally, benzene was identified as the primary constituent of concern in a groundwater contaminant plume that originates beneath Site SS-06 (ICF Technology, 1995).

In September 1995, Parsons ES collected additional soil gas samples to determine if soil gas beneath the site was oxygen depleted. Soil gas samples were collected from two wells on the north side of the bermed area and from one well on the east side of the bermed area. Soil gas samples were field-analyzed for oxygen and total volatile hydrocarbons (TVH). Oxygen concentrations in soil gas ranged from 1.0 to 7.5 percent. TVH concentrations in soil gas ranged from 2,400 parts per million, volume per volume (ppmv) to over 20,000 ppmv. Low oxygen concentrations in soil gas indicated that soil microbes were consuming oxygen faster than it could naturally diffuse into the soils, and that air (oxygen) injection would enhance the rate of fuel hydrocarbon biodegradation. Based on previous soil sampling results and the September 1995 soil gas screening results, the Air Force Center for Environmental Excellence (AFCEE) determined that a bioventing pilot test should be conducted to determine the feasibility of using bioventing to remediate site soils.

In July 1996, Parsons ES installed and tested a pilot-scale bioventing system near the former location of Tank 7000 as part of the AFCEE Extended Bioventing program (Contract No. F41624-92-D-8036, Order 17). Under this program, Site SS-06 was funded for pilot-scale bioventing system installation and testing and full-scale system installation (using two Option 3's), 2 years of extended system operation with maintenance and monitoring (two Option 1's), and completion of confirmatory soil sampling (Option 2).

Following successful testing of the pilot-scale bioventing system, a full-scale bioventing system was designed and installed in July and August 1996. The full-scale bioventing system is shown in Figure 1. The full-scale bioventing system consists of eight vent wells (VWs), nine vapor monitoring points (MPs), and a blower unit. During installation of the pilot-scale

system, respiration and air permeability testing and soil and soil gas sampling were performed. Based on oxygen influence and air permeability testing performed during installation of the pilot-scale system, the long-term radius of oxygen influence was expected to exceed 65 feet at depths between 5 and 14 feet bgs and 100 feet at depths between 14 and 20 feet bgs. A detailed description of the bioventing system design and initial site activities are provided in the *Bioventing Pilot Test Results and Full-Scale System Installation Report for POL Yard, Sites SS-06 and ST-40* (Parsons ES, 1996).

Following completion of full-scale system installation and testing, the system was started, optimized, and operated continuously for 1 year. In August 1997, the system was shut down for 36 days to allow soils and soil gas to reach equilibrium in order to compare initial and 1-year conditions. Soil gas sampling and *in situ* respiration testing were performed from 15 through 18 September 1997. Results of the 1-year testing event were provided by Parsons ES (1997) to AFCEE and Wurtsmith AFB. Following 1-year testing, the blower system was restarted to continue bioventing treatment of site soils.

In September 1998, the bioventing system was shut down for 28 days to allow development of equilibrium conditions in site soils and soil gas for the 2-year testing event. Soil gas sampling and *in situ* respiration testing were performed from 13 through 17 October 1998 as described in Section 4 of the *Final Confirmation Sampling and Analysis Plan for POL Yard, Sites SS-06 and ST-40* (Parsons ES, 1998). Results of the 2-year soil gas sampling and respiration testing event are presented in this report.

Following 2-year testing, confirmation soil sampling was performed by Parsons ES in accordance with Section 5 of the *Final Confirmation Sampling and Analysis Plan for POL Yard, Sites SS-06 and ST-40* (Parsons ES, 1998). Results of the confirmation soil sampling event will be provided under separate cover in a forthcoming report. Following confirmation soil sampling, the blower system was restarted to continue bioventing treatment of site soils.

During 2-year testing and confirmation soil sampling, nearby construction of a combined air sparging/soil vapor extraction (AS/SVE) was observed. The AS/SVE system is currently being installed by Amtech in areas north and east of the POL Yard, with construction and system components extending into the northeast corner and east side of the site. This system has been designed to remediate the light non-aqueous phase liquid (LNAPL) plume and fuel-hydrocarbon contamination present in smear zone and shallow-saturated zone soils and groundwater between Site SS-06 and the Benzene Plant. The system is scheduled to begin operation in late 1998 or early 1999.

SOIL GAS CHEMISTRY RESULTS

Field screening and collection of soil gas samples for laboratory analyses were performed on 13 October 1998, following approximately 1 month of system shutdown. Soil gas samples were collected from the VWs and each MP screened interval. The samples were field-screened to assess soil gas concentrations of oxygen, carbon dioxide, and TVH following 2 years of full-scale bioventing operation. In addition, soil gas samples were collected from eight MP screened intervals and submitted for laboratory analysis. As can be seen from the results presented in Table 1, soil gas field TVH measurements and laboratory results have decreased significantly at most locations as the result of 2 years of full-scale bioventing system operation.

In general, static oxygen concentrations in soil gas samples collected from the VWs have increased significantly with continued bioventing treatment. Exceptions are at VW5 where static oxygen concentrations have remained at 0 percent, and VW7 and VW8 where oxygen concentrations have measured between 5.5 and 8.5 percent during the 1-year and 2-year sampling events. At the MPs, static oxygen concentrations have generally increased at the 5- to 12-foot screened intervals, with the exception of MPC-12 and MPD-12, where no oxygen has been detected under static testing conditions since bioventing system operation began in August 1996. Similarly, no oxygen has been observed under static testing conditions at the 18- to 20-foot depth intervals during the initial, 1-year, and 2-year testing events. The distribution of soil gas oxygen concentrations indicates that residual fuel contamination throughout the site is primarily limited to a thin smear zone associated with the fuel impacted groundwater surface. Depleted soil gas oxygen concentrations measured in the smear zone indicate that aerobic hydrocarbon biodegradation rates remain relatively high and exceed the rate at which oxygen can naturally diffuse into the soils from the ground surface and adjacent uncontaminated areas. Natural diffusion of oxygen into site soils is greatly restricted because of the impermeable liners covering most of the POL Yard. Static oxygen results suggest that significant substrate (total fuel hydrocarbons) is limited to unsaturated site soils within the smear zone and that only low concentrations of fuel hydrocarbons remain in soil above the smear zone.

Although soil gas field screening results for oxygen suggest that significant concentrations of biodegradable fuel hydrocarbons remain in site soils, soil gas field TVH measurements and laboratory results for TVH and BTEX indicate a significant reduction of residual fuel hydrocarbons in soils at most locations following 2 years of bioventing system operation. Soil gas field TVH screening results presented in Table 1 indicate a greater than 92 percent average reduction in TVH at the VWs, 83 percent at MP screened intervals above the smear zone (5 to 12 feet bgs), and 24 percent at MP intervals in the smear zone (18 to 20 feet bgs). These data likely underestimate the actual reduction of TVH because the 2-year TVH results include methane while the initial and 1-year results do not include methane. At MPD-18, MPF-20, and MPI-18, significant increases in field TVH concentrations were observed. These increases can be attributed to a lower groundwater surface elevation during the 2-year sampling event, resulting in a greater thickness of contaminated smear zone soils being exposed to the vadose zone.

Soil gas samples for laboratory analysis were collected at eight locations during the 2-year testing event. As with previous soil gas sampling events, samples were submitted to Air Toxics, Ltd laboratory in Folsom, California for TVH and BTEX analysis by US Environmental Protection Agency (USEPA) Method TO-3. At MPA-11, MPB-18, MPC-5, MPC-18, MPG-18, and MPI-18, 2-year sampling results can be compared to both initial and 1-year sampling results. As shown in Table 1, the most significant TVH and BTEX reductions (nearly 2 orders of magnitude) are apparent for samples collected from MP intervals screened above the smear zone (MPA-11 and MPC-5). Although initial TVH and BTEX concentrations in smear zone soil gas were similar to initial concentrations in shallower soil, TVH and BTEX reductions resulting from 2 years of full-scale bioventing system operation are not as significant in the smear zone. At MPB-18, MPC-18, MPG-18, and MPI-18, where both initial and 2-year data are available, TVH and total BTEX concentrations were reduced, on average, by 77 percent and 36 percent, respectively. Lesser reductions in TVH and BTEX concentrations measured in smear zone soil gas is likely the result of a lower groundwater surface during the 2-year sampling event. During the 2-year sampling event, the groundwater

surface was 2 to 3 feet lower than previous sampling events and contaminated soil that was previously saturated was exposed in the vadose zone. Bioventing treatment of these smear zone soils has been limited and is only effective when these soils become exposed during periods of low water table conditions.

Field and analytical soil gas results suggest a significant degree of remediation has occurred in the unsaturated soils at Site SS-06. Increased static oxygen concentrations, and low TVH and BTEX concentrations in soil gas samples collected above the smear zone indicate that fuel hydrocarbons in these soils have been reduced considerably. Soil gas field and laboratory analytical results also indicate significant, but lesser, remediation of smear zone soils at the site.

IN SITU RESPIRATION TEST RESULTS

In situ respiration (oxygen utilization) testing was performed at the POL Yard from 14 through 17 October, 1998. The testing was performed according to protocol procedures (Hinchee *et al.*, 1992) and followed 28 days of bioventing system shutdown. Air was injected for 20 hours into MPA-11, MPC-12, and MPC-18; and for 22 hours into MPE-18, MPG-18 and MPH-18; using 1 cubic-foot-per-minute (cfm) pumps, to locally oxygenate site soils. Following air injection, changes in oxygen, carbon dioxide, and TVH soil gas concentrations were monitored over a 73-hour period at MPA-11 and MPC-12, and over a 49-hour period at MPC-18, MPE-18, MPG-18 and MPH-18. Observed rates of oxygen utilization were then used to estimate aerobic fuel biodegradation rates at Site SS-06. Table 2 summarizes initial, 1-year, and 2-year respiration and fuel biodegradation rates at Site SS-06.

Compared to initial rates, observed oxygen utilization and calculated fuel biodegradation rates have decreased at MPA-11, increased at MPC-12 and MPC-18, and remained essentially unchanged at MPE-18 following 2 years of bioventing system operation. Initial rates are not available for MPG-18 and MPH-18, but rates at these locations decreased slightly during the second year of bioventing treatment. The mixed results are likely related to the lower groundwater level observed during the 2-year testing event. The lower groundwater level has exposed a larger interval of contaminated soils thereby increasing the biological oxygen demand of these smear zone soils.

Oxygen utilization and fuel biodegradation rates typically decrease with continued bioventing as the lighter, more readily biodegraded hydrocarbons are preferentially destroyed over more biologically recalcitrant, higher molecular weight hydrocarbons. As demonstrated by the soil gas results presented in Table 1 and, to a lesser extent the *in situ* respiration testing results presented in Table 2, fuel hydrocarbon concentrations have been significantly reduced at most locations, but sufficient hydrocarbons remain in the unsaturated soils to sustain moderate respiration rates.

CONCLUSIONS

Based on soil gas sampling and respiration testing results obtained following 2 years of full-scale bioventing system operation, fuel hydrocarbons in the unsaturated soil at Site SS-06 have been greatly reduced. However, significant concentrations of aerobically biodegradable fuel hydrocarbons may remain in site soils in localized areas within the smear zone. Based on the overall reduction in soil gas TVH and BTEX following 2 years of bioventing treatment, the

October 1998 collection of confirmation soil samples to determine whether or not site contaminants have been reduced to below generic MDEQ cleanup criteria, appears appropriate.

Parsons ES will evaluate confirmation soil sampling results against MDEQ closure criteria and prepare a results report for Sites SS-06 and ST-40. When complete, Parsons ES will provide AFCEE and Wurtsmith AFB with the draft confirmation soil sampling report for review and comment. If you have any questions or require additional information, please contact either John Hall at (970) 244-8829 or John Ratz at (303) 831-8100.

Sincerely,

PARSONS ENGINEERING SCIENCE, INC.

Craig B. Snyder
for
John F. Hall, P.E.
Site Manager

John W. Ratz
John W. Ratz, P.E.
Project Manager

Attachments: Figure 1, Tables 1 and 2

cc: Mr. Paul Rekowski, Wurtsmith AFBCA
File 726876.69210.E Letter Results Report

REFERENCES

Brown & Root Environmental. 1995. *Final Report for the Closure of the Fuel Hydrant System, Wurtsmith AFB, Michigan*. December.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frendt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing*. Prepared for USAF Center for Environmental Excellence. May.

ICF Technology, Inc. 1995. *The United States Air Force Installation Restoration Program Site Characterization Summary, Sites SS-06, SS-13, and SS-40*. March.

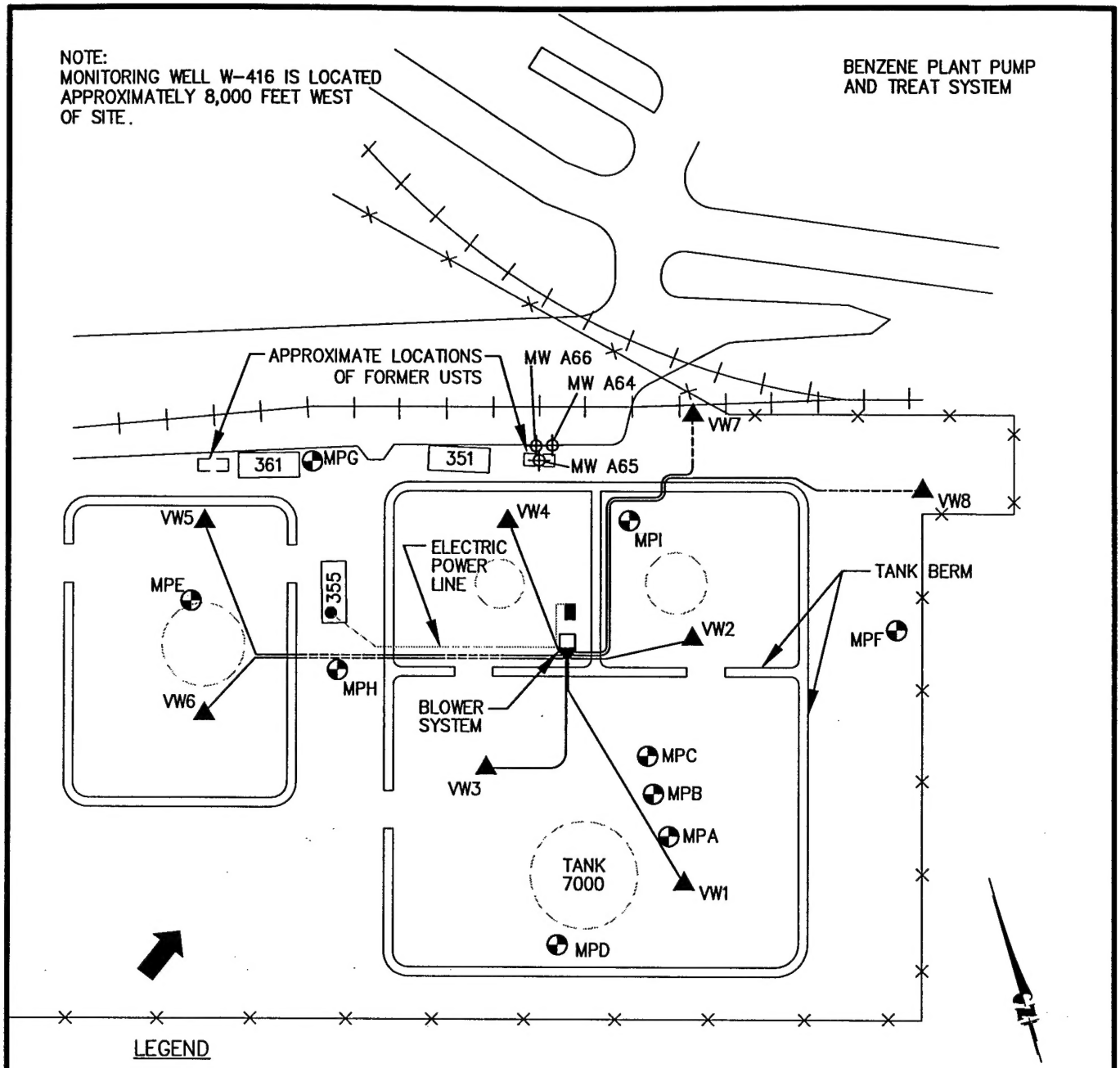
Michigan Department of Environmental Quality (MDEQ). 1995a. *Interim Environmental Response Division Operational Memorandum #8, Revision 4: Generic Residential Cleanup Criteria*. June 5.

Michigan Department of Environmental Quality (MDEQ). 1995b. *Interim Environmental Response Division Operational Memorandum # 14, Revision 2: Remedial Action Plans Using Generic Industrial or Generic Commercial Cleanup Criteria and Other Requirements*. June 6.

Parsons ES. 1996. *Bioventing Pilot Test Results and Full-Scale System Installation Report for POL Yard, Sites SS-06 and ST-40, Wurtsmith AFB, Michigan*. November.

Parsons ES. 1997. Letter to AFCEE re: 1-year Testing Results for Full-Scale Bioventing at the POL Yard, Sites SS-06 and ST-40, Wurtsmith AFB, Michigan. October 14.

Parsons ES. 1998. *Final Confirmation Sampling and Analysis Plan for POL Yard, Sites SS-06 and ST-40, Wurtsmith AFB, Michigan*. September.



LEGEND

- CHAIN LINK FENCE
- GROUNDWATER FLOW DIRECTION
- VW3 ▲ AIR INJECTION WELL
- MPA ⊕ VAPOR MONITORING POINT
- MW A65 ⊕ GROUNDWATER MONITORING WELL
- AIR PIPELINE, DASHED WHERE BURIED
- FORMER AST LOCATION
- ● EXISTING ELECTRICAL DISTRIBUTION PANEL AND NEW ELECTRIC METER
- ■ NEW ELECTRICAL DISTRIBUTION PANEL AND MOTOR STARTER

0 50 100 200

Approximate Scale In Feet

FIGURE 1

AS-BUILT FULL-SCALE BIOVENTING SYSTEM LAYOUT

Sites SS-06 and ST-40
Wurtsmith AFB, Michigan

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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TABLE 1
INITIAL, 1-YEAR, AND 2-YEAR SOIL GAS FIELD AND LABORATORY ANALYTICAL RESULTS
POL YARD, SITES SS-06 AND ST-40
Wurtsmith AFB, Michigan

			Field Screening Data			Laboratory Analytical Data[a/]					
Sampling Location	Screen Depth (ft bgs)[c/]	Sampling Event[d/]	Oxygen (percent)	Carbon Dioxide (percent)	TVH[b/] (ppmv)[e/]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Xylenes (ppmv)	Total BTEX (ppmv)
VW1	7-22	Initial	0.0	12.1	> 20,000	----[f/]	----	----	----	----	----
		1-Year	0.0	10.8	17,000	----	----	----	----	----	----
		2-Year	3.2	6.5	720	----	----	----	----	----	----
VW2	7-22	Initial	0.0	14.2	8,000	----	----	----	----	----	----
		1-Year	1.8	9.0	----[g/]	----	----	----	----	----	----
		2-Year	4.3	7.3	800	----	----	----	----	----	----
VW3	7-22	Initial	0.0	13.0	5,600	----	----	----	----	----	----
		1-Year	5.0	7.0	320	----	----	----	----	----	----
		2-Year	12.2	3.0	480	----	----	----	----	----	----
VW4	8-23	Initial	0.0	8.8	> 20,000	----	----	----	----	----	----
		1-Year	0.5	4.5	340	----	----	----	----	----	----
		2-Year	4.6	3.6	400	----	----	----	----	----	----
VW5	8-23	Initial	0.0	12.6	> 20,000	----	----	----	----	----	----
		1-Year	0.0	9.5	2,000	----	----	----	----	----	----
		2-Year	0.0	9.4	2,600	----	----	----	----	----	----
VW6	8-23	Initial	0.0	13.4	11,200	----	----	----	----	----	----
		1-Year	8.9	3.5	400	----	----	----	----	----	----
		2-Year	13.9	1.9	400	----	----	----	----	----	----
VW7	13-23	Initial	7.8	7.5	4,600	----	----	----	----	----	----
		1-Year	8.5	6.2	260	----	----	----	----	----	----
		2-Year	7.5	6.6	840	----	----	----	----	----	----
VW8	14-24	Initial	6.8	9.2	2,400	----	----	----	----	----	----
		1-Year	7.0	7.6	1,120	----	----	----	----	----	----
		2-Year	5.5	8.1	880	----	----	----	----	----	----
MPA	5	Initial	0.0	12.2	17,200	----	----	----	----	----	----
		1-Year	0.0	10.8	440	----	----	----	----	----	----
		2-Year	6.1	5.8	640	----	----	----	----	----	----

TABLE 1 (Continued)
INITIAL, 1-YEAR, AND 2-YEAR SOIL GAS FIELD AND LABORATORY ANALYTICAL RESULTS
POL YARD, SITES SS-06 AND ST-40
Wurtsmith AFB, Michigan

			Field Screening Data			Laboratory Analytical Data[a/]					
Sampling Location	Screen Depth (ft bgs)[c/]	Sampling Event[d/]	Oxygen (percent)	Carbon Dioxide (percent)	TVH[b/] (ppmv)[e/]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Xylenes (ppmv)	Total BTEX (ppmv)
MPA	11	Initial	0.0	12.0	> 20,000	22,000	69 M[h/]	100	31	65	265
		1-Year	0.0	10.9	5,000	1,500	< 0.11	0.37	0.25 M	1.4 M	2.02
		2-Year	1.2	9.1	840	6.9	0.0089	0.018	0.029	0.21 M	0.27
MPA	18	Initial	0.0	12.3	> 20,000	----	----	----	----	----	----
		1-Year	0.0	10.6	9,800	----	----	----	----	----	----
		2-Year	0.0	10.8	2,760	----	----	----	----	----	----
MPB	5	Initial	2.0	10.2	17,600	----	----	----	----	----	----
		1-Year	0.5	10.5	280	----	----	----	----	----	----
		2-Year	5.2	7.4	920	----	----	----	----	----	----
MPB	12	Initial	0.0	12.0	> 20,000	----	----	----	----	----	----
		1-Year	0.0	11.4	1,780	----	----	----	----	----	----
		2-Year	1.8	10.1	880	----	----	----	----	----	----
MPB	18	Initial	0.0	12.1	> 20,000	25,000	70	110	33	76	289
		1-Year	0.0	11.5	16,000	7,100	< 0.53	11	23	130	164
		2-Year	0.0	13.0	14,200	1,900	4.7	5.6	26	50	86.3
MPC	5	Initial	0.0	11.2	> 20,000	24,000	58	120	32	70	280
		1-Year	0.0	12.0	1,240	570	< 0.11	1.7	1.3	3.3	6.3
		2-Year	2.2	10.6	1,560	4.2	0.10 M	0.061	0.050	0.16 M	0.33
MPC	12	Initial	0.0	11.0	19,200	----	----	----	----	----	----
		1-Year	0.0	12.5	5,600	----	----	----	----	----	----
		2-Year	0.0	13.0	1,280	----	----	----	----	----	----
MPC	18	Initial	0.0	11.0	> 20,000	20,000	57	94	26	58	235
		1-Year	0.0	12.8	19,200	11,000	< 1.1	25 M	12	64 M	101
		2-Year	0.0	14.6	17,400	3,500	18	27	24	40	109
MPD	12	Initial	0.0	13.1	6,000	----	----	----	----	----	----
		1-Year	0.0	14.5	10,400	11,000	< 1.1	23 M	14	58	95
		2-Year	0.0	14.9	14,800	4,300	23	30	22	57	132

TABLE 1 (Continued)
INITIAL, 1-YEAR, AND 2-YEAR SOIL GAS FIELD AND LABORATORY ANALYTICAL RESULTS
POL YARD, SITES SS-06 AND ST-40
Wurtsmith AFB, Michigan

Sampling Location	Screen Depth (ft bgs)[c/]	Sampling Event[d/]	Field Screening Data			Laboratory Analytical Data[a/]					
			Oxygen (percent)	Carbon Dioxide (percent)	TVH[b/] (ppmv)[e/]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethyl-benzene (ppmv)	Xylenes (ppmv)	Total BTEX (ppmv)
MPD	18	Initial	0.0	13.2	4,000	16,000	38	99	34	40	211
		1-Year	NS[i/]	NS	NS	----	----	----	----	----	----
		2-Year	0.0	15.1	18,200	----	----	----	----	----	----
MPE	18	Initial	0.0	11.2	> 20,000	----	----	----	----	----	----
		1-Year	0.0	10.7	4,000	6,300	< 2.66	12	20	130 M	162
		2-Year	0.0	12.0	3,560	1,400	0.66 J[j/]	0.80 J	30	56	87.5
MPF	20	Initial	0.0	13.8	3,600	----	----	----	----	----	----
		1-Year	NS	NS	NS	----	----	----	----	----	----
		2-Year	0.0	15.2	> 20,000	----	----	----	----	----	----
MPG	18	Initial	0.0	10.4	> 20,000	38,000[k/]	145[k/] M	96[k/]	30[k/]	54[k/]	325[k/]
		1-Year	0.0	14.0	16,400	18,000	< 1.1	61 M	23 M	110 M	194
		2-Year	0.0	14.6	> 20,000	4,800	32	18	28	59 M	137
MPH	18	Initial	0.0	7.8	19,600	21,000	43	61	14	26	144
		1-Year	0.4	14.0	4,000	----	----	----	----	----	----
		2-Year	0.0	14.8	3,720	----	----	----	----	----	----
MPI	18	Initial	0.0	13.8	9,800	15,000	55	81	20	34	190
		1-Year	0.0	15.0	19,200	32,000	< 5.4	41 M	26	130 M	197
		2-Year	0.0	15.4	> 20,000	12,000	100	56	38	140	334
MW-A64	N/A[l/]	Initial	1.0	---	> 20,000	----	----	----	----	----	----
		1-Year	0.0	14.0	16,400	----	----	----	----	----	----
		2-Year	---	---	---	----	----	----	----	----	----
MW-A66	N/A	Initial	NS	---	NS	----	----	----	----	----	----
		1-Year	0.0	15.2	> 20,000	----	----	----	----	----	----
		2-Year	---	---	---	----	----	----	----	----	----
W-416 (Background)	8-18	Initial	20.5	0.7	16	----	----	----	----	----	----
		1-Year	---	---	---	----	----	----	----	----	----
		2-Year	---	---	---	----	----	----	----	----	----

TABLE 1 (Continued)
INITIAL, 1-YEAR, AND 2-YEAR SOIL GAS FIELD AND LABORATORY ANALYTICAL RESULTS
POL YARD, SITES SS-06 AND ST-40
Wurtsmith AFB, Michigan

[a/] Laboratory analysis of soil gas performed using USEPA Method TO-3. Laboratory TVH referenced to jet fuel (MW=156).
[b/] TVH = total volatile hydrocarbons. For field screening results; initial and 1-year concentrations exclude methane, 2-year results include methane.
[c/] ft bgs = feet below ground surface.
[d/] Soil gas sampling performed in July and August 1996 (initial), September 1997 (1-year), and October 1998 (2-year).
[e/] ppmv = parts per million, volume per volume.
[f/] ---- = not analyzed.
[g/] Field TVH measurement not documented in the field book.
[h/] M = Laboratory reported value may be biased due to apparent matrix interferences.
[i/] NS = No sample collected; MP screened interval was saturated.
[j/] J = Estimated value. Compound was detected but was below the reporting limit.
[k/] Result averaged with duplicate sample result.
[l/] N/A = Information not available.

TABLE 2
INITIAL, 1-YEAR, AND 2-YEAR RESPIRATION AND FUEL BIODEGRADATION RATES
POL YARD, SITES SS-06 AND ST-40
Wurtsmith AFB, Michigan

Location-Depth[a/]	Oxygen Utilization Rate (% O2 /hr)[b/]			Biodegradation Rate (mg/kg/year)[c/ d/]			Soil Temperature (°C)		
	Initial (August 1996)	1-Year (September 1997)	2-Year (October 1998)	Initial (August 1996)	1-Year (September 1997)	2-Year (October 1998)	Initial (August 1996)	1-Year (September 1997)	2-Year (October 1998)
MPA-5	----[e/]	----	----	----	----	----	8.3	16.9	15.0
MPA-11	0.45	0.31	0.23	2,500	1,710	1,310	----	----	----
MPA-18	0.08	----	----	400	----	----	16.6	13.1	13.9
MPC-12	0.15	0.19	0.22	820	1,080	1,170	----	----	----
MPC-18	0.15	0.18	0.58	780	1,000	3,110	----	----	----
MPE-18	0.44	0.19	0.42	2,100	930	2,030	----	----	----
MPG-18	----	0.40	0.34	----	1,910	1,650	----	----	----
MPH-18	----	0.35	0.33	----	1,680	1,570	----	----	----

[a/] Location-Depth gives screened interval location and depth in feet below ground surface (bgs).

[b/] % O_2 /hr = percent oxygen per hour.

[c/] Initial, 1-year, and 2-year biodegradation rates based on moisture content of the soil during initial sampling.

[d/] mg/kg/year = milligrams of hydrocarbons per kilogram of soil per year.

[e/] ---- = not measured or not calculated.